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ABSTRACT

A conference was held to discuss educational issues related to mathematics and science education. This document reports the proceedings of the conference by summarizing the comments of several of the conference speakers. The speakers and topics discussed included: (1) Senator Mark Hatfield and Congressman Thomas Sawyer on the perspective of Congress' support for educational change in mathematics and science; (2) Deputy Secretary of Education David Kearns on the six National Education Goals and the American 2000 strategy: (3) Charles Dickens (Executive Secretary of the Federal Coordinating Council on Science, Engineering and Technology) and Milton Goldberg (Director of the Office of Research of the Office of Educational Research and Improvement in the Department of Education) on increased cooperation among providers of mathematics and science education; (4) Samuel Betances and Shirley Malcom on equal mathematics and science education for all students; (5) Cathy Seeley and Joseph Rosenstein on quality teaching and inservice teacher education; (6) several speakers on educational standards at national and state levels that are being proposed for curriculum, teaching, and assessment by groups such as the American Association for the Advancement of Science, the National Council of Teachers of Mathematics, the National Research Council, the Mathematical Sciences Education Board, and State Boards of Education in California, Arkansas, and Connecticut; and (7) participants' views on leadership roles, mathematics and science supervisors, the Eisenhower National Clearinghouse, and the creation of regional consortia for the Clearinghouse. The report concluded with views from members of the Department of Education concerning the issues discussed. (MDH)

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The Dwight D. Eisenhower Pro
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The Triangle Coalition for Science and Technology Education has prepared this conference report for the U.S. Department of Education.

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A Secure Nation

Mathematics and science education's champion in the Senate, **Senator Mark O. Hatfield (Republican, Oregon)** stood before Eisenhower conferees as a "convert" from a narrow liberal arts bias. "As you all know," he said, "converts can either be obnoxious or have great perception." As an Appropriations Committee leader (first as chair, currently as ranking member), Hatfield's broadened vision has consistently led him to support education in general and the "Eisenhower fields" in particular, long before they recaptured the national spotlight.

Hatfield's support has led to an education appropriation of $31.7 billion dollars, up 17 percent from last year. He also sponsored the Excellence in Mathematics, Science, and Engineering Education Act of 1990. In addition, Hatfield came to the Eisenhower meeting immediately after launching the Elementary Science Facilities Act in the Senate, which aims to provide basic hands-on equipment to every elementary student. It proposes $30 million federal dollars a year for the next three years, which, when matched by state and local dollars, will total $180 million.

The Real Meaning of National Security

Dwight D. Eisenhower, said Hatfield, was the first president who truly understood this issue. "All other presidents have been seduced by the military—if not already by their own convictions—that the nation's security is measured by the megatons in its arsenal." And their response—Kennedy and Reagan's in particular—has been to escalate military spending.

In contrast, Hatfield said, recognizing that without a tight infrastructure, defense is in danger, Ike launched what he called "a national *defense* highway system." Eisenhower was also firmly committed to the quality and accessibility of education.

Many things besides networks and education make up national security, Hatfield emphasized, mentioning health, nutrition, and housing as examples. "An adequate arsenal alone will not save a nation. It was not our military superiority—not SDI, MX, or chemical weapons—that unraveled the USSR," he went on. "It was its flawed social and economic system, including its narrow base of educational opportunity."

This being the case, it is appropriate that the Education for Economic Security act of 1984 was renamed the Eisenhower Program in 1988. Funding has been increasing dramatically ever since.

Why Emphasize Mathematics and Science and Why Stress Equity?

"Selfish reasons," explained Hatfield. The reality is that they are key to the nation's social, political, and economic future. Projections show that by 2000, 85 percent of the new employees joining the work force will be the underrepresented—women, minorities, handicapped, and immigrants—so the moral imperative of equity has also become economic. In addition, Hatfield explained, "We must also retain and expand the scientific and technological work force: Demand is rising and supply is diminishing.

"An elite system of managers resting on the labor of drones will not suffice if our productivity is to grow, if we are to be globally competitive. The top 30 percent of Americans are getting richer," Hatfield said, "while the 70 percent remaining is getting poorer."* Seventy percent of the total jobs available by the year 2000 will not require a college education.

"We're heading toward a two-class society," he warned.

To fight this trend, Hatfield has cosponsored the High Skills, Competitive Work Force Act of 1991. This, with Eisenhower, could be one "of the stepping stones to a new competitive America." But the programs mentioned here are not the panacea, Hatfield continued.

Besides being employed and educated, a truly secure nation is healthy.

You Can't Separate Education and Health

The health care research and delivery systems in the United States are chaotic, Hatfield noted. While the "big three," cancer, heart, and AIDS get lots of—but not necessarily sufficient—funds, less publicized afflictions do not. Hatfield contrasted the escalation years ago in funding for research on AIDS—from $300 million one year; to $600, the next year; to $900; to $1.2 billion; to $2 billion next year—to the 2,000-plus "orphan diseases" that receive neither attention nor research monies.

They are represented by the National Organization for Rare Diseases (NORD), and most don't have a national registry, let alone a research project While occasionally a poignant sufferer gets his/her affliction some public attention (and therefore some research support), "this is not the way this kind of problem should be handled," Hatfield emphasized.

"We spend $270 million for Alzheimer's research; 4 million people have the disease.

"We have the manpower and womanpower to deliver health care to everyone." He noted the 11,000 training grants just authorized to the National Institutes of Health. "Just give me the funds for a B1 or B2 or B *anything* bomber," he pleaded, "and let's use the money for national health instead."

But here is Hatfield's worry: "We're going to be appropriating money, and there won't be researchers to apply for it, if we don't deal with the failure to increase productivity in the education of mathematicians, scientists and engineers:

- "You're not promoting a parochial viewpoint.
- "You're not a vested interest group.
- "You cannot separate health and education.

"As math/science people," he concluded, "You, your disciplines, and your students are the key to our future economic strength, to our national defense, and to our quality of life."

*The statistics and projections Hatfield presents come largely from a study by the Commission on the Skills of the American Workforce (1990, June), *America's Choice: High Skills or Low Wages!* (Rochester, NY: National Center on Education and the Economy).

No Two Cultures

Hatfield explained his and similarly educated friends' original "snobbish attitude that mathematics and science students were not fully educated." This bias, he said, was not only the fruit of his background in liberal arts, as student, teacher, and administrator, but also his observation that debaters from the liberal arts usually defeated their mathematics and science competitors.

As a future politician, Hatfield *noticed* when debaters from the humanities defeated medical students attacking socialized medicine and engineering students defending public works.

"We concluded," laughed Hatfield, that "knowledge of the fundamental forces of life was possible only through the humanities: The liberal arts always won.

"We now know," he said seriously, "that education is indivisible."*

*"The chasm," he said, "may be between basic and clinical/applied science research."

Change

Third-term Congressman Thomas C. Sawyer (Democrat, Ohio) came to Congress looking for a place where he could "make a difference." He found it in America's education, an institution older than the Constitution, particularly in the fields of mathematics and science, which are changing at the speed of light.

Sawyer sees an urgent need for radical change both in the unique American "overarching concern" to provide solid, meaningful public education for all its children and in the nation's approaches to learning these two essential disciplines. "We need to understand," Sawyer said, "that science is something that you do rather than something that you learn." And how many pupils are figuring calculations, he wondered, rather than learning a structure through which they can better understand their world.

Mathematics and science—the "Eisenhower disciplines"—Sawyer believes, are the "place where the force of demographic change and education trend lines come together" and will be "the point at which an enormous amount of domestic policy and the United States' place in the world will be defined."

Speeding the Learning Curve

When children ask him how to choose their future professions, Sawyer said, he tells them to keep an open mind: "The world is changing so fast that you don't pick a career," he explains. "Instead, you pick disciplines that have the potential to come together in ways that allow you to develop a place to stand."

To give our youngsters this opportunity, Sawyer said, "We desperately need to speed the learning curve. The target is moving faster than the ball we're throwing at it."

Change now, he elaborated, is as fundamental as the change in technology of 100 years ago that drove global reorganization and migration unlike that of any other period in history. Populations, freed by application of power to production, moved from the farm to the city. And "our industrial model of flexible production systems" is having the same difficulty in keeping up with the moving target as are educators.

"But the model of education put into effect 100 years ago remains." His colleagues didn't originally share his enthusiasm, seeing the Ike program as comprising a series of "many unfocused slush funds, with too many agendas, scatter-shot approaches, and unbelievably complicated formulas for the distribution of funds."

Changing the Face of Education in the United States

Although the Constitution doesn't mention education, Sawyer said, its writing was preceded by the land ordinances of 200 years ago, which "intertwined schools, funding, property, and localities." Only much later did school administration pass to the states. While this history means that support of education is very deep, it also means that traditions are entrenched, Sawyer said, and "embedded in decisions made 200 years ago."

These policies weren't really reformed, he continued, until a century ago during a "time of enormous global change not unlike what we're going through today." But even those changes pale in the face of the new realities of the 1990s; we now need to make profound structural changes that go "beyond curriculum, beyond teaching technique, beyond parental support, beyond tax funding, beyond anything else."

Reformers face "structural impediments" that go deep into the beliefs and history of our society, Sawyer noted, saying that it is not sufficient to "play catch-up ball, as we have for the last hundred years." Unfortunately, he said, "It is in those terms, based on the past, that the national goals are framed: Do more of what you were doing, but do it better.

"I think their establishment has a tragic flaw," he admitted, "in that it does not realize the speed of change."

Eisenhower Grows

After an inauspicious existence for a number of years—"the Ike program came very close to extinction in mid-1980s," Sawyer remembered—the program has gained "a tight and purposeful constituency" on the Hill. It is now "a point of nexus in a number of force and trend lines to effect change," Sawyer said. This year's increase to $248 million—"very good numbers" in today's economic climate—continues the Appropriations Committee's pattern of increases for the Eisenhower program; funding has gone up 300 percent since 1988's $80 million.

In 1990, the passage of the Excellence in Mathematics, Science, and Engineering Act through both houses of Congress was an important step in making Eisenhower a powerful catalyst for excellence. In part to combat the chaos wrought by America's 16,000 decidedly unequal school districts, the Act's amendments proposed the Eisenhower National Clearinghouse and related regional consortia.

As examples, Sawyer compared Florida and Ohio, states similar in most demographics. Florida, however, has 66 school districts, while Ohio has 617—after consolidation. "School districts' lines," explained Sawyer wryly, "were put in place by the deity shortly after the flood, and you better not try to change them." In the face of this disorder, Congress proposed the creation of a clearinghouse—"a permanent repository of that which is exemplary in math and science education" to widely disseminate workable methods of curriculum and instruction through attached consortia.

Education as the Overarching National Concern Structure

Historically, Sawyer said, townships devoted 1/16th of their land value to pay for schooling, but neither the structure nor the money remains sufficient to make education the centerpiece it should—and must—be. While that arena is the one place where funding continues to rise, Sawyer emphasized, it's not increasing fast enough.

The Eisenhower program is designed to give appropriators the confidence to continue to provide funds for mathematics and science, "while leaving teachers and administrators the *flexibility* . . . to cope with enormous changes, respecting the unique and changing needs of a large and diverse country." The job of the Congress, Sawyer concluded, is to accumulate sufficient funds for education and then leave the experts free to decide where the monies can most effectively be spent.

The House version of S-2 reflects education as a major priority, Sawyer noted. "It includes the hoopla and banners, but it also tries to get to more fundamental principles." Sawyer predicted that Americans are "likely to see interlocking elements of higher education reauthorization come together in a massive interaction" with other levels of schooling.

"Head Start and an affordable college education for people of ordinary means," Sawyer summed up, "are part and parcel of the same concern."

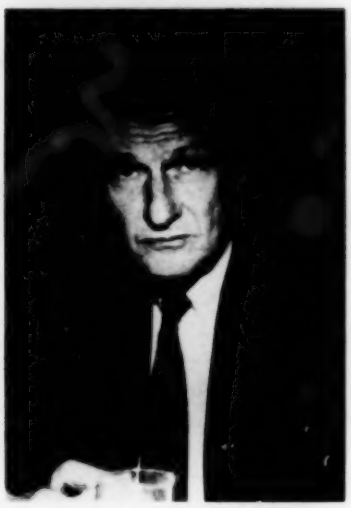
"Stand Back, Boy, This is Official Police Business!"

Sawyer shared a memory with conferees:

When he was the "brand new mayor" of Akron in the early hours of a cold January morning, he called 911 to get help for someone a bystander had found unconscious in a snowbank. Gratified at the police and paramedics' swift appearance, Sawyer went out to compliment them and to ask how he could help. Responded the sergeant, "You can stand back, boy: This is official police business."

"It's in that spirit," Sawyer laughed, "that I come before this group of math and science educators this morning..."

Lessons From the Corporate World



Deputy Secretary of Education David T. Kearns, coming to the Department from his post as chief executive officer at Xerox, has no problem embracing the president and governors' fourth goal. He admitted that he understands the objections of those who wouldn't have framed it in such "a nationalistic, macho way." But maybe, Kearns said, striving to be first in science and math is not so different an impulse from John Kennedy's promise that "We're going to the moon."

Emphasizing that education is the "fundamental underpinning" leading to resolution of many national issues, Kearns mentioned its essential potential contribution to America's international productivity and competitiveness. Now, as always, the United States is educating the top half of its population. But "we have never excelled at teaching everyone," he said, "and this is what the six goals and the *America 2000* strategy are all about."

Kearns expressed "concern" at the people and groups satisfied with a 70 percent success record. "Can you imagine," he asked, "me giving a sales pitch about Xerox products by saying that 65 percent will be all right and not worrying about those who get the other 35 percent?"

Raising Expectations

In fact, he continued, he is "still offended" when he sees an ad proclaiming that "We build the best car *in America.* Consumers want the best product wherever it is," he said. "We need the best school system *in the whole world,* one that fits our society, communities, states, cities, and towns."

Travel in Asia taught Kearns that the Japanese recognized that to compete they had to raise standards substantially. One important reason why "Japanese business leaders are taking American executives to the cleaners" is because the Japanese had much higher goals for success than did the Americans. Inside and outside of education, over the last 25 years, Kearns went on, "we have begun to moderate our expectations. And I believe that the beginning of changing this nation is raising our expectation levels."

He does not advocate copying the Japanese or the Northern Europeans but "finding the best practices and bringing them home to see how they fit into what we're doing."

Changes must be forced from outside: No institution changes from within.

The Goals in Context: *America 2000*

The goals framed in 1990 by the governors and the president express appropriately high expectations, Kearns emphasized, noting that it was now time to establish agendas to meet those goals. Predicated on the belief that "all children can learn," the goals apply to everyone, he said, including those in at-risk communities.

Kearns likened this conviction to the one underlying the quality process in the business world: "All employees want to work hard, have high expectation levels, and want the corporation to be successful." In education as in industry, "the leadership's responsibility is to provide the environment, the training, the expectation levels, and the strategy so that everybody can be successful."

Putting the *America 2000* goals into effect will call for cooperation among many groups—federal, state, local, professional, private, and others. The reform will take time and entail risks, he admitted, calling for patience, support, and understanding of occasional failures. Kearns sees the activities of the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) as having useful implications for *America 2000.*

Standards are a Race Without a Finish Line

"Understand," warned Kearns, "that as we develop these standards, they will change." Adapting for educators the slogan he created for Xerox as it moved and changed through the 1980s, "Quality is a race without a finish line," Kearns noted that "as we put in place a strategy and a process for change, we'll find we can raise standards substantially" and continually. This process will require new curriculum frameworks, a supportive federal government, and better colleges of education "driving the country toward being competitive."

Once teachers graduate, Kearns emphasized, they must be able to put into practice their inservice training. This is not always the case now "because the environment at their school is not ready to take in new ideas." So *America 2000* calls for concerted effort not just from teachers of mathematics and science, but also the staffs, the principals, the district- and state-level administrators, and the community.

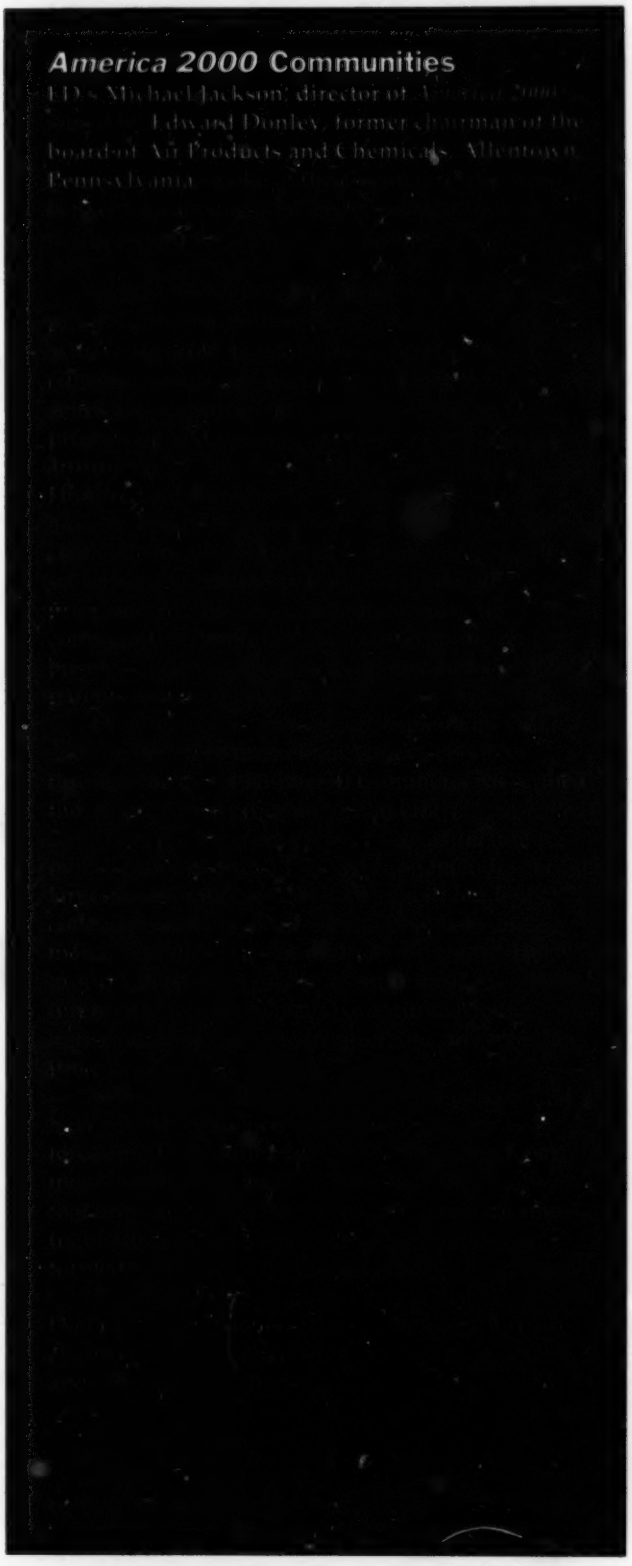
"Each of you, besides being interested in math and science," Kearns noted, "lives in a community" including, often, a university and a school system. He urged participants to become involved in community strategies for educational change. Not only is it necessary to meet "the challenge of *America 2000*" to work nationwide with governors, chief state school officers, and educators, but also to involve the community to

- inspire acceptance (or adaptation) of the education goals (for example, Memphis has defined eight)
- develop a strategy so members understand what is expected each year
- plan and support a new school for the next decade

Uniquely American

Kearns recently "plowed" through the Japanese curriculum for math, and "I'll tell you, it is scary." He believes, however, that by proceeding innovatively "at the same time we are improving the schools year by year, school by school," we can have by 2000 "110,000 of the best schools in the world."

Most people have an opportunity to read about, do research about, and write about revolutions, Kearns noted. But few historically have had the opportunity to participate in them. "All of you," he concluded "are involved in what I hope will turn into a real revolution that will be extraordinarily important to our nation."



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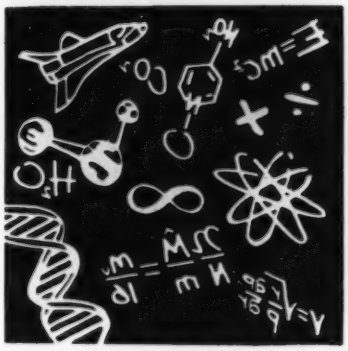
Inter- and Intra-Agency Cooperation



Cover design, *By the Year 2000: First in the World*

Conferees heard of the increased cooperation among providers of mathematics and science education at ED from **Steering Committee Chair Milton Goldberg, Director of the Office of Research of the Office of Educational Research and Improvement (OERI)** and across the federal government from **Executive Secretary Charles H. Dickens** of the **Federal Coordinating Council on Science, Engineering and Technology (FCCSET).**

FCCSET

Addressing conferees on behalf of the president's science adviser D. Allan Bromley, Dickens, of the White House Office of Science and Technology Policy, briefly sketched FCCSET's history. The FCCSET Committee on Education and Human Resources (CEHR) coordinates mathematics, science, and engineering education programs across 16 federal agencies and cabinet departments. It is specifically devoted to improving education in these fields in line with the national education goals and the *America 2000* strategy. (See back cover.)

Eisenhower programs are a major means for federal agencies to achieve goal four, Dickens said. Some $1.94 billion worth of federal programs are specifically directed at improving science and mathematics education; many others (like Chapter 1) pay for it indirectly. The FCCSET-CEHR inventory* shows experts and volunteers locally and federally in all 16 agencies.

The CEHR focuses primarily on elementary and secondary levels and has as its planning priorities teacher preparation and enhancement; research and development in curriculum; comprehensive programs like the National Science Foundation's (NSF) Statewide Systemic Initiative;* student incentives; and increasing underrepresented groups. The biggest change, Dickens said, is a more than 13 percent increase over fiscal year 1991 in funds for math and science education. The NSF and ED received 86 percent of funds for precollege programs. Undergraduate and graduate programs also continue to receive significant, growing support.

The ED Steering Committee

Speaking on the analogous work of FCCSET and the ED Steering Committee, Chair Goldberg, in part from his work on the much-quoted *A Nation at Risk* (1983), knows well the problems American education faces. The Steering Committee works to list and coordinate ED's diverse programs for science and mathematics education, as FCCSET does government-wide; the Committee also considers possible initiatives and meets with members of other federal agencies when appropriate.

Although the Committee's work is complicated by the Department's organization of content by level and function rather than subject, its recent report* describes 26 currently functioning programs in ED with science and mathematics components and how they are disseminated. "We need to narrow the gap between what we know," Goldberg said, "and what we do."

He welcomes Assistant Secretary and Counselor to the Secretary Diane Ravitch's suggestion to create a National Library of Education as part of ED's dissemination process and concurs that electronic methods and networks should complement traditional paper transmissions.

*For a copy of the second CEHR FCCSET Report, *First in the World by the Year 2000* (Washington, DC: Author) contact FCCSET, CEHR, c/o NASA, Education Division, Office of Human Resources and Education, 400 Maryland Ave., S.W., Washington, DC 20546. Telephone: (202) 453-3504.

For further information on FCCSET activities, contact Dr. Dickens at the Office of Science and Technology Policy, 744 Jackson Pl., N.W. Washington, DC 20506. Telephone: (202) 395-5101. Fax: (202) 395-1314.

For further information on the NSF's Statewide Systemic Initiative, contact the SSI, Directorate for Education and Human Resources, NSF, Room 635, Washington, DC 20550. Telephone: (202) 357-7731.

For further information on the ED Steering Committee, contact Dr. Goldberg at 555 New Jersey Ave., N.W., Room 5573, Washington, DC 20208-5573. Telephone: (202) 219-2088.

Won't or Can't?

Goldberg noted that making American students *want* to be educated—and not just in science and math—is the major issue. The answer, he emphasized, does not lie only in the schools, which, admittedly, must be improved but also with parents and communities. He pointed out this dichotomy:

- If Asian parents found that their children were not "good at math," the explanation was that they "didn't try hard enough."
- If American parents found the same problem, the explanation was that their young "just were not good at it.

"Our youngsters can do much better," said Goldberg, "than we think they can and they think they can."

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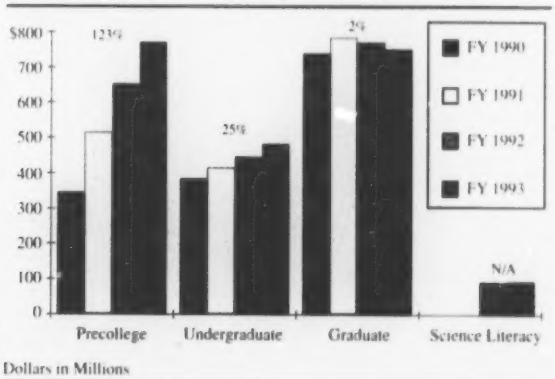
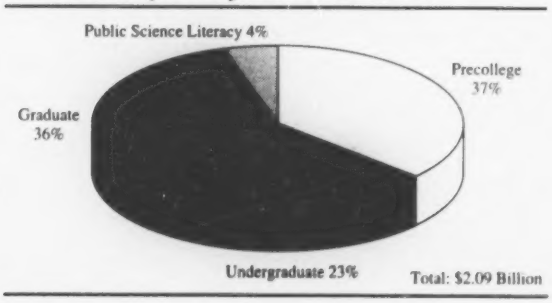
FY 1990-1993 Growth by Education Level



FY 1993 Request by Education Level



Source: *By the Year 2000: First in the World*, FCCSET CEHR report, January, 1992

Professional Organizations

Alliance for Environmental Education
P.O. Box 368
The Plains, VA 22171
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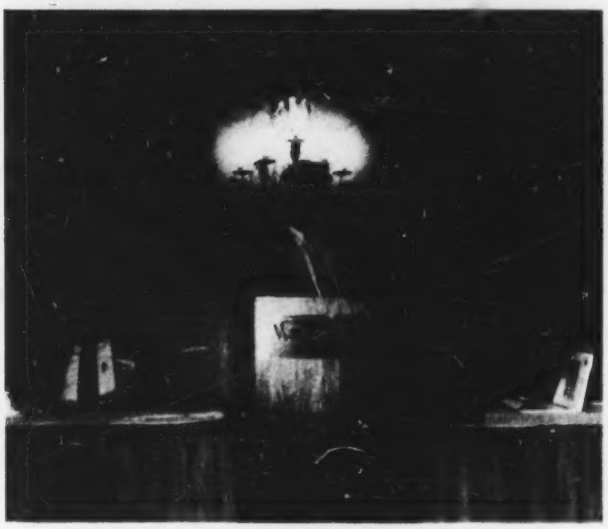
1+1+1=0
Diversity as Plus, Equity as Must

Samuel Betances, professor of sociology at Northeastern Illinois University, representative of America's diversity, mobility, and success, and holder of the doctorate from a "somewhat prestigious university," made the conference's theme of access personal and immediate.*

Diversity as a Plus

"One of the biggest challenges we have to face in American society, Betances said, "is how to make sense of our differences, so that our chemistry doesn't kick into negative expectations.

"We have to realize," he continued, "that our cultural legacy is to be suspicious of those persons, or groups, or neighborhoods that have been stigmatized." Educators must discard this cultural legacy to function to maximum impact and worth. Moving from principle to particular, Betances elaborated:



> People like me are not going to go away.... What I really want is to make a contribution to this society, community, family, self, a contribution larger than the current scripts allow me.
>
> I've got "fire in my belly."** I'm hungry to matter. I am endowed with skills and talents. I have a sense of humor, of purpose, and I'm interested in making coalitions of interests, not coalitions of color.

Betances can work "separate and apart from something called the minority agenda," he said, because no one can pretend to be producing worthwhile American citizens without teaching students "to embrace the diversity all around us." Educators who deny access to those outside the mainstream prevent contributions from individuals like Betances: "You cheat yourself out of a tremendous, important, positive force to work with you in reaching our collective goals as a *heterogeneous* society."

Everything from the neck down is minimum wage.

Bias in the Land of Equality

Betances' savior, Mary Yamasaki (see box on page 15), had been interned in the United States during World War II. "Sometimes we only get it half right," he said. "We don't even understand why certain groups are here, why we welcome some groups with open arms as refugees . . . and not others." We are also confused about what makes an unhyphenated American: "If you tell Mexican-Americans to 'go back where you came from,' they go to Texas, Arizona, New Mexico, California."

The U.S was also at war with Italy, he noted, "but we didn't put Joe DiMaggio behind barbed wire. We were at war with Germany, and we used Eisenhower, a man of German descent, to bring Germany to its knees."

Under guise of providing security, America was "actually putting a double standard into play."

*A limited number of taped versions of Betances' speech are available at $7.50 (send check or money order to Gary G. Allen at the Triangle Coalition). A videotape of Betances speaking in Albuquerque in 1989 can be purchased for $25 plus $4 postage and handling (send check or money order to Souder, Betances, and Associates, Inc., 5448 N. Kimball Ave., Chicago, IL 60625).

**An allusion to Sam Keen's recent autobiography.

Illiterate—or Empowered—in Two Languages

The Americans taught English to a racially mixed, Spanish-speaking, Catholic, rural, poor population in Puerto Rico "not as a form of empowerment," Betances said, "but to separate them from their former loyalties":

"Speak English."

"Si."

"Forget Spanish."

"OK."

While aiming to learn "middle-class English," an activity Betances supports "without apology," students were supposed to "get rid of Spanish," one he deplores.

The need for English is clear, he said. Two-thirds of books are published in English; 70 percent of the information stored on diskettes is stored in English. "Anyone who thinks that you can get along in the United States without English is a fool," Betances emphasized. "Anyone who believes you can go on into the 21st century with only English is a greater fool."

Quoting a Goethe proverb, Betances said, "If you gain a new language, you gain a new world (in Hungarian, 'a new soul')."

The opposite is also true.

The Right Models and the Wrong Models

"Japan," said Betances "cannot be our role model because it is literally full of Japanese people." Neither can Sweden. "Why go to a homogeneous society to create role models for a heterogeneous society?" he asked. "It does not compute.

"Somehow, instead, we've got to go to Washington, D.C. We've got to go back to Kansas, back to Eisenhower's hometown in Kansas."

He described the "cooperative learning" he shared at the boarding academy into which Mary Yamasaki's help, faith, and persistence had placed him. A preppy classmate noted Betances' oratorical gifts, and the two made a deal:

"If you teach me to do what you do, I will teach you how to say it right."

Betances' mentors for middle-class English were also Scottish preacher Peter Marshall, Billy Graham, and John F. Kennedy—each of whom he mimicked for applauding conferees.

Not an Industrial but a Technical Revolution

As well as we are doing in our best schools—those serving the academically motivated rather than the disadvantaged and discouraged—if we continue our

And They're All Made Out of Ticky-Tacky, And They All Look Just the Same*

"Besides nose jobs," Betances said, "people have

name jobs

religion jobs

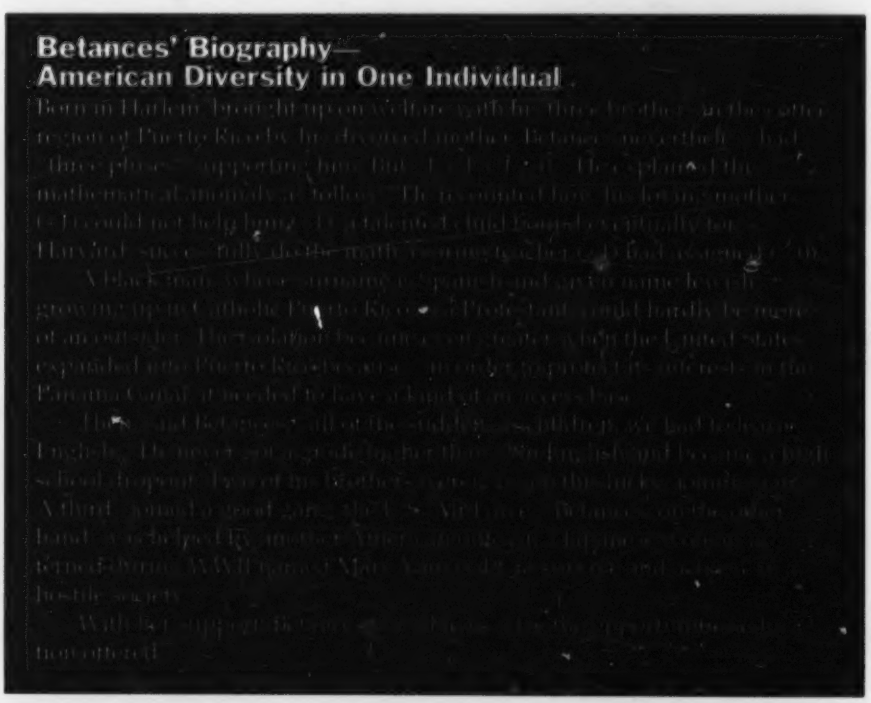
elevator [shoe] jobs

"Whatever you've got," he said, "is not good enough." Women hide their stretch marks, the proof that they have *brought life into the world!*

The lesson for teachers: Maybe they don't know what it means to be black or Hispanic, but they know what it means to be bald, or fat, or have lines on their faces. "We can appeal to our own frustrations as vehicles by which we can show empathy."

*From the song "Little Boxes." Words and music by Malvina Reynolds. © 1962 Shroeder Music Company. Renewed 1990. Used by permission. All rights reserved.

Betances' Biography—American Diversity in One Individual



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teaching unaltered, we will be "in jeopardy," Betances believes.

1. "We don't know how to teach the best and the brightest; therefore, the money spent empowering middle-class kids to become better at learning is well-spent, but

2. "For the first time we have to educate everybody."

We have to take the children at the bottom scholastically—the result of "poor diets and poor health in homes where abstract thinking is neither expected nor rewarded and leap-frog them in with the academically proficient," Betances believes, even though we don't know how to teach either group. Helping all the students to succeed in math and science is as essential as it is difficult.

Minorities and immigrants coming to the work force today are in about the same circumstance as European immigrants of a century ago, Betances believes. Yet the overall drop-out rate has never been lower in the history of this country than it is today. That among blacks today (40 percent) is much lower than the 94 percent it was for first generation Americans 100 years ago.

But today's immigrants and other minorities "arrived at the wrong time, when the age of the strong back had yielded to the age of technology." Today's disadvantaged deserve the same kind of chance through education that many of their predecessors had through other factors.

Now education can serve to empower people—although it does not often do so. People don't know what they want, Betances pointed out, until they know what options are available. As one possible change to alter the kind of arithmetic (1 + 1 + 1 = 0) against which Betances originally struggled, he suggests community homework centers, maybe at McDonald's, "where kids are paid for flipping ideas rather than hamburgers."

Mathematics and science can open doors of opportunity, he said, even before children learn the majority's language. Before we empower you with English, "we will do what we must to give you math, formulas, and so forth. Until you learn English, we will teach you science and technology so you can contribute to the society—paying taxes rather than living off them."

He reminded educators, however, that "You don't teach math or science; you teach human beings from diverse backgrounds." Betances is "amazed" at the young men who sell and deal with drugs

> at how good they are at adding, subtracting, and developing formulas to eliminate the opposition. They know how to create systems through which they cannot to be detected by police; they know how to think abstractly; they know how to use technology and math; what they don't know is how to be educated; how to be complete; how to be spiritually grounded; how to be happy; how to be part of society; how to make democracy work.

Somehow, he said, "we have to go beyond the technology, beyond abstract thinking, with a commitment to make the house of democracy work for everyone.

"We must do differently to get different outcomes.

"Let's get the scripts right!"

How Do You Look?

"White males," said Betances, "still do most of the flying—except on weekends when you have to sign up 30 days in advance and stay over Saturday night—that's when the masses fly."

The "master status" question white men ask each other, Betances said is, "What do you do?" It is quickly followed by, "What is your name?" to which the answer is "Rick, or Bob, or sometimes really long names like "Howard."

When Betances flew during the Gulf crisis, he found himself, for a change, at a certain advantage: "Everyone was always looking at me; they didn't know what to do with me," he said. "They would huddle together and ask each other—'Who's that Gadhafi*-looking guy over there?'"

Then they would ask not "What do you do?" but "Where are you from?"

"'Relax, it's OK,' I'd respond, 'I'm from Beruit.' Then, I was never afraid that my attache case will be stolen. If I put it down, someone would quickly say, 'Excuse me, sir, don't forget your briefcase!'"

*Betances refers to Libyan leader Moammar Gadhafi, suspected of involvement in several airline bombings.

The Participants Speak: Opening Mathematics and Science to All

Conferees broke into seven groups organized by region to share the ways their programs were increasing access to underserved groups—females, minorities, and the handicapped, both as students and as teachers—in particular geographic areas. They examined the priorities for and efficacy of such programs in helping students and in recruiting teachers. A compilation of responses follows.

Background: A number of participants noted that while cities generally serve the most diverse populations, rural areas also contain many disadvantaged and isolated students who need special help. Many reported a growing population of Asians. A fundamental problem: In the face of growing numbers of minority students, the population of minority teachers (already at a lower percentage than their students) is declining. And, noted one participant, "You need to help teachers of minority students as well as minority teachers."

Another problem: Local sources are often unable to match or even contribute funds—This means it is difficult for programs funded by Eisenhower to achieve maximum impact.

"You've got to sell the program with *one-on-one interactions* between college faculty and teachers. Personal contact with professors will get the minorities into the classes. Publicity—by itself—leaves minorities science-scared."

♦

"You need a multi-faceted approach—Hispanic young women with children have to be paid to be able to go to school as students or as future teachers. They need tuition, babysitters."

♦

"Open up areas that haven't been touched. Open doors or provide advisors and consultants. Instead of always recruiting the 50 best master teachers, change what you're looking for. Don't lower standards but look differently: Don't just look at the teachers in the best schools."

How is Eisenhower Serving the Underrepresented?

- by getting out the word that educators are eager to help
- sending recruiters to minority recruitment fairs
- special programs—*Equals, Zoo Project*
- early intervention
- Gender Ethnic Expectations and Student Achievement (GEESA) on how to address multiple groups in classrooms
- affirmative action assurances written into programs as priority items
- *Boosting Educational Awareness in Minorities*
- staff development sessions on how to teach the underserved
- *Making Mathematics Accessible to All*
- adaptive curriculums for the handicapped
- coordinating funding and cooperative projects to leverage outreach
- increasing access instead of holding students back

What are the Priorities for Such Programs?

- providing access for *all* teachers
- exposing teachers to different cultures and providing tools
- using cooperative learning models
- publicizing working programs
- holding workshops *where teachers are* even if it's "not convenient"
- broadening access with manipulatives, technology, hands-on materials in combination with cultural understanding

Featured Programs That Work: Increasing Access to Mathematics and Science

Representatives of seven of the Eisenhower state and national programs briefly described their program's individual successes in raising mathematics and science consciousness and achievement in girls, minorities, and/or handicapped students, as well as helping their teachers deal most effectively with challenging subject matter and diverse student populations.

- Alabama Operation Physics
  —Marllin T. Simon, Eloise T. Kirk, presenters
  Telephones: (205) 844-4337
  (205) 242-8199

- American Indians in Mathematics (AIM)
  —Wayne J. Stein, presenter
  National Program
  Telephone: (406) 994-3881

- Facilitating Adaptive Curriculum: Innovation in Teaching Science (FACITS)
  —Ralph Nelson, Marilyn Wells presenters,
  National Program
  Telephones: (503) 760-2346
  (918) 225-5600

- Integrated Science, Mathematics, and Language Arts
  —Jim Woodland, presenter
  Nebraska
  Telephone: (402) 471-4329

- Minority Mathematics and Science Education Cooperative (MMSEC)
  —Nan Boussard, Wayne W. Carley, Ellen Montgomery, Olga Ramirez, presenters
  Texas
  Telephones: (512) 483-6224/(409) 880-8260/
  (512) 343-8102/(512) 381-3631

- New Jersey Family Science
  —Rebecca Lubetkin presenting for Arlene S. Chasek
  Telephone: (908) 932-2071

- Project SENSE: Science Education Network for the Southeast
  —Delmer Presley, presenter
  Georgia
  Telephone: (912) 681-5444

- writing needs assessments that target the underserved
- identifying and targeting minority districts and helping rural children overcome isolation
- focusing efforts on physically challenged, mentally handicapped, females, gifted and talented, and "kids who aren't aware of their options"
- offering rural outreach *on site* with scientists in residence

What Programs Encourage Women, Minorities, and the Handicapped to Become Science and Math Teachers?

- teachers observing other teachers
- appropriate role models
- workshops publicizing available careers
- concentration on preservice recruitment
- forgiveness on scholarships or loans
- salary subsidies to districts hiring minority teachers
- *Common Grounds Consortium*
- *Alliance to Involve Minorities in Mathematics*
- retraining programs for ethnically diverse teachers interested in certification in science or math

What Programs Empower Students?

- workshops for parents
- programs pairing minority students with science teachers
- cooperative learning and learning centers
- separate competitions (which don't exclude participants from regular projects)
- involved families
- improved access for all rather than splinter-group targeting
- culturally relevant curriculums
- student mentors from culture of concern

How Is Success Measured?

- attendance at professional meetings
- summer courses
- inservice staff development
- networking
- new, funded opportunities for women and minorities to go to workshops
- count of underserved taking math and science
- increased achievement
- lowered drop-out rates

Achieving Equity and Excellence

Shirley M. Malcom, who heads the American Association for the Advancement of Science's Directorate for Education and Human Resources, sets her sights high. She envisions a society and an educational system that provides to all Americans who so choose access to careers in science and technology. And she offered some pointers on achieving this ambitious goal. But we're certainly not there yet, she emphasized: "The failure to provide quality math and science education for all" has led to a twofold loss. It not only deprives young people unfairly excluded from the opportunity to be part of the scientific and technological fields they might choose. It also cheats those fields of "significant talent, different experiences and insights, and multiple contexts" through which professionals could view the problems they research and the applications to which they apply their findings.

Malcom advocates that educators "go after equity and excellence at the same time" and plan "to achieve both without sacrificing either." She noted, however, that heretofore, careers in mathematics, science, and technology have been "limited by limiting experiences for the disadvantaged and for minorities." The latter include "large groups, including young women of all races; American-Indian, African-American, Mexican-American, and Puerto Rican males; and students with disabilities."

Now, in most schools, Malcom noted, "opportunities come from outside and are unequal; those opportunities present are not seized; and the opportunities available inside are not available to all children.

"Only through a total restructuring of science, mathematics, and technology education will we achieve either or both equity and excellence," she warned.

A Fair Shot

Giving everyone a fair shot does *not* mean giving everyone an *equal* shot, Malcom emphasized. "We are different individuals coming from different places taught by different people," she pointed out, "but somehow we need shared standards." Getting to those shared standards, offering that fair shot, means understanding and coping with the differences among students—in preparation, in environment, even in development.

As an example of why equality does not guarantee equity, Malcom cited the length of lines in ladies' rooms. "Why are they always so long?" she questioned. "Why are there lines at all?" A recent study rejected most previous explanations of this phenomenon ("reasons advanced by men," she noted, laughing), finding instead that it takes women longer—physically—than men to use the facilities. So in this case, *"equal is not equitable.* If women are to have a fair shot, a three to two ratio of stalls is equitable."

Applying the "rest-room principle" to achieving equity in science and technology education is not a simple matter of counting, of course. But Malcom did note several essential approaches.

We have to get more air-time for science, mathematics, and technology.

Steps for Success

Research has pointed out a number of fruitful directions toward equity in pedagogy, in curriculum, and in educational environment, Malcom said. "Teachers need a positive attitude and high expectations," she noted, and should, for example, "deliberately choose non-white boys and girls for active roles, as demonstrators, explainers, and models" rather than only those students who volunteer spontaneously.

Educators should

- encourage *all* to persist in science, mathematics, and technology courses
- provide role models who look like their students
- foster cooperation

Many teachers need specific training to attend to issues of active participation, Malcom said, to notice, for example, "who uses material and who merely watches or listens."

Curriculums should emphasize hands-on approaches that focus on problem solving and tie to real world issues, should encourage interdisciplinary approaches, connecting to science and mathematics in many ways, and should support the national goals for literacy. Research shows, Malcom said, that children will engage with curriculums that speak to them, that have meaning for their lives, and that respect the cultures from which they come.

Finally, she emphasized, educators "have to connect the opportunities inside and outside the school; we have to connect the school and the home." She noted *Family Math* and *Family Science* programs as successes in this endeavor. She also pointed out that while U.S. education functions as "nonlinear systems (and, therefore, at times, *chaos*), schools are open systems affected by many influences.

"We can get synergy in schooling only if we make the pieces fit together," she concluded, "especially school, home, and community.

"We cannot change the system unless the structure changes, but resistance to change is inherent in any system," Malcom said. "Homeostasis is the ruling principle, as the system tries to return to its lowest energy state." She noted that there is, therefore, a profound need for continued pressure for reform during the disruptions change causes.

Startling Statements

As a point of departure, Malcom offered these figures:

- In 1973-1974, women received 3.4 percent of bachelors' degrees in engineering; in 1988-1989, 15.2 percent.
- In 1973-1974, women earned 41 percent of the bachelors' degrees in math; in 1988-1989, 46 percent. (Thus, she said, math is nearly "gender neutral" at the baccalaureate level.)
- In 1987, 25 percent of male high school graduates took physics, compared to 15 percent of the females.
- In 1975, black Americans earned 41 Ph.D. science degrees; in 1990, 23.

Source—
Betty F. Vetter, Ed. (March, 1991)
Professional Women and Minorities.
Washington, DC:
Commission on Professionals in Science and Technology

Linking Equity to Excellence

The 1990s are a time of "great ferment," Malcom said, as numerous national groups work to define "what is excellence?" She noted especially the work of the National Council of Teachers of Mathematics *Standards*, the American Association for the Advancement of Science's *Project 2061*, and the National Science Teachers Association's *Scope, Sequence, and Coordination*. (For more information on these developing national curriculums, as well as the work of the Mathematical Sciences Education Board, see pages 21-23 of this report.)

All three of these professional organizations are working to set standards—an important process, which, Malcom said, is "national but not federal" in scope and connects to state curriculum frameworks. Because there must be local alignment among standards, curriculum, instruction, and assessment, Malcom emphasized the need for connection between certification and teacher education. Assessment is central, she admitted but "it is not, or should not, be the driver of the changes taking place."

Bill G. Aldridge, executive director of the NSTA, and **F. James Rutherford, education director for the AAAS** briefed conferees on the progress of the two curriculums on which their respective organizations are working. **David H. Florio, principal staff officer for the NRC's Coordinating Council for Education,** reported on the progress of the work of the National Committee on Science Education Standards and Assessment.

NSTA'S *SS&C*—Off the Drawing Board and into the Classroom

Planned to affect junior high through high school students, *SS&C* substitutes an integrated cross-disciplinary secondary science curriculum for the illogical and unappetizing "layer cake" approach of the past, Aldridge said. Graduating seniors take these tiers of subject matter: 80 percent, biology; 40 percent, chemistry; 20 percent, physics; a few percent, earth science.

This wide-bottomed cake is frequently sliced horizontally: The majority of U.S. students quit the study of science forever after ninth-grade biology. *SS&C* curriculums, however, would plan to have all students to take *all* major fields over *all* their 7-12 grade years.

SS&C projects in Texas, California, Iowa, Kansas, North Carolina, and Puerto Rico are funded and currently operating, Aldridge said, with Alaska also beginning to implement one. These programs involve some $11 million in federal funds, plus considerable local money. In addition, Glencoe Division of Macmillan/McGraw Hill, Prentice-Hall, and Harcourt Brace Jovanovich, among others, will soon be bringing out textbooks reflecting *SS&C*'s approach, often in tandem with that of *2061*.

Aldridge described two new developments in *SS&C*. First, he said, "We are planning a capstone course in science at grade 12," to be offered to top-level college-bound students who have gone 7-11 through *SS&C*. Aldridge is also personally working on an assessment project using an interactive compact disk. Eventually, he hopes this tool, whose development is being funded by Eisenhower, will be available to schools for about $700.

As in nearly all its efforts on behalf of improved science education, Aldridge said, NSTA's approach in *SS&C* is collaborative in nature. Thus, although the AAAS' *Project 2061* covers grades K-12 and approaches the reform in science education through different emphases and time schemes, both share the same goal of greater scientific literacy through better education. "We at NSTA develop company standards but not industry standards," Aldridge said. NSTA cooperates toward the goal of teaching students science better not only with AAAS, but also with representatives of particular fields such as the American Association of Physics Teachers, and—in the matter of developing science standards—with the National Academy of Sciences.

AAAS' *Project 2061:* At Work in a "Necessarily and Luckily Messy" World

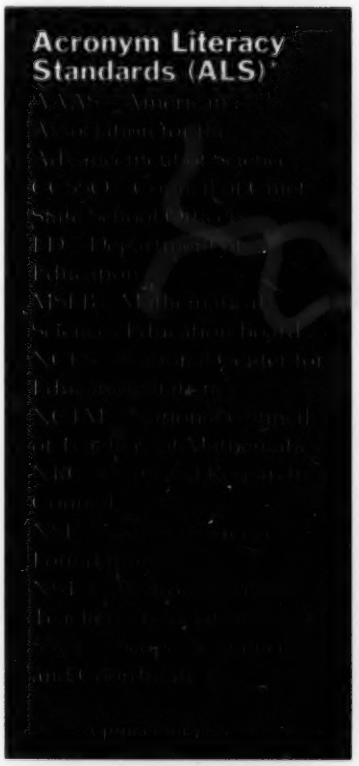
Although he joined Aldridge in admiring the National Council of Teachers of Mathematics' ground-breaking work on standards, the AAAS' Rutherford noted a possible down side to certain kinds of consensus. "Many nations that we envy don't have standards," he noted, but they do have fixed curriculums and exit exams.

For further information on *SS&C*, contact Russell Aiuto or Martin A. Apple at NSTA, 1742 Connecticut Ave., N.W., Washington, DC 20016. Telephone: (202) 328-5800.

Science for All Americans is available from Oxford University Press, 200 Madison Ave., New York, NY 10016. Telephone: (800) 334-4249, ext. 7109.

Synergy in Science

NSTA
AAAS
NRC



BEST COPY AVAILABLE

"Fortunately, we've gone a long time with out them." America's diverse 16,000 school districts mean that uniformity is most unlikely, and Rutherford finds this desirable. "What tools like standards can do," he said, is to provide "a weak force field with vectors heading in sort of the same direction."

Project 2061, which finished Phase I with the publication of *Science for All Americans* (1989), emphasizes the importance of student familiarity with sociology, archaeology, anthropology, technology, engineering, and so forth as well as the traditional scientific disciplines stressed by *SS&C*. Currently, during Phase II, teams of educators are designing a *variety* of curriculum models to offer school districts interested in reforming science education. Phase III—implementation—lies ahead.

"Coming up with standards blessed by the highest forces could keep us from radical reform," Rutherford asserted. "If we come up with standards with which most of us feel *uncomfortable*, we'll probably be OK.

"We try in *Project 2061* to find benchmarks in both content and style—how content is distributed, how learning is organized, how outcomes are assessed. We'd like to be able to say 'At each of these places, this is what students should know and be able to do...'"

NRC's Plans for Science Education Standards*

The NRC's committee on which Florio serves will oversee the development of a set of science education standards modeled on the two original NCTM *Standards* volumes on curriculum and teaching, as well as a third on assessment. Its members will include a broad constituency of the science and education populations; national, state, and local educators; teachers; and students.

The Committee's mandate comes from a letter from NSTA presidents past, present, and future to National Academy of Science President Frank Press asking the Academy to convene and coordinate the development of standards for science education.

In addition to school science, the NRC will branch to undergraduate education. Besides modelling itself on the standards published by the NCTM, the NRC will also work to integrate its efforts with those standards. Curriculums should be planned, Florio said, at least K-12 but eventually K-16.

Resource materials being reviewed for the science education standards will come from programs like NSTA's *SS&C*, the AAAS' *Project 2061*, states' guidelines, and the like. The Committee intends, however, to set standards that encourage a great deal of individual freedom, suggesting that programs proceed in "parallel rather than linear" fashions. Notwithstanding these plans for broad latitude, Florio said, thus far "We are finding a remarkable degree of consensus" among the many members of the science education community. The Committee plans three working groups on science

- **curriculum standards,** which will *not* set up courses of study or syllabi but try to point to what students should know in science and technology
- **teaching standards,** which will focus on the quality of teacher preparation, professional development, and materials that will make standards real without being dictatorial or rigid
- **education assessment,** which will embed its work in that of those focusing on teaching and curriculum and will strive to develop assessments that reflect standards

*For further information on the science education standards, contact Dr. Florio at the NRC, 2101 Constitution Avenue, N.W., HA 450, Washington, DC 20418. Telephone: (202) 334-1487.

Change in Mathematics: The NCTM's *Standards* Work at the MSEB

James D. Gates, executive director of the NCTM, and **Ray C. Shiflett, executive director of the MSEB,** described the past and current work of their organizations in creating benchmarks for mathematics curriculum, teaching, and assessment. They also outlined for conferees their plans for the future. Although the impact and effectiveness of the NCTM's 1989 curriculum standards for school mathematics are beyond question, it is still "too early," Gates said, to measure the effect of its 1991 volume setting forth teaching standards. The organization is, however, conducting a state-by-state survey to try to find out how widespread teachers' use is. Results, Gates said, should be available for the NCTM's annual meeting April 1-4 in Nashville.

The NCTM will work with the MSEB to produce a third volume on assessment to accompany its original two. The NCTM is also involved in a number of projects that support and expand the work of the K-12 Standards.

"Much of what the MSEB does," Shiflett said "is in cooperation with other organizations, especially mathematics groups." At the school level, its major collaboration is with the NCTM, particularly in its support of the teaching and curriculum standards published in 1989 and 1991.

The MSEB has recently published *For Good Measure,* which presents a framework for national standards for mathematics assessment to accompany the NCTM's two ground-breaking volumes. MSEB's work in assessment has been primarily to review current—and ideal—goals and principles and to collect nationwide feedback to align future assessment standards with general educational and societal needs.

Other recent MSEB publications analyzing school mathematics include *Everybody Counts* (1989), an overview; *Reshaping School Mathematics* (1990), a curriculum framework; and *Counting on You* (1991), a teaching overview. The MSEB has distributed more than 100,000 copies of these three publications in every state and the District of Columbia. A parents' kit including a video and a booklet for students and parents is also available.

In addition, the MSEB has helped put together 51 coalitions to serve as places where the public and educators can come together to work jointly on educational reform. And the MSEB's work on exemplary types of fourth grade mathematics assessment issues, begun in 1991 with the work of the Writing Group, should shortly be complete (see page 24).

Along with the Mathematical Association of America, the MSEB is also beginning to work at the university level to more deeply involve faculty in undergraduate mathematics reform. The Association's major publication in this arena is *A Call for Change* (1991).

NCTM Projects

- Addenda—22 booklets elaborating on curriculum *Standards*
- *Number Sense, Number Concepts,* and *Computation*—three videotapes funded by Eisenhower and developed by Francis (Skip) Fennell of Western Maryland University, which should be ready for the for the NCTM annual meeting • an algebra videotape developed for teachers of eighth and ninth graders—*Algebra for Everyone*—which is accompanied by an inservice guide and book
- five videotaped units shot in classrooms on calculator-enhanced mathematics instruction for grade levels K-3, 4-5, 6-8, and 9-12 (these materials are also available in text form)
- speaker resources and public service announcements

For further information about the NCTM Standards, other publications, and other programs, contact the NCTM, 1906 Association Drive, Reston, VA 22061. Telephone: (703) 620-9840.

For further information about MSEB publications and activities, contact the MSEB at 2101 Constitution Avenue, N.W., HA 476, Washington, DC 20418. Telephone: (202) 334-3294. *For Good Measure* is available free from the MSEB while supplies last. To contact the coalition in your area, telephone the MSEB's state coalition office at the phone number listed above.

Assessment:

NSTA's *SS&C*
CCSSO
MSEB

In light of the adoption of the national education goals, concurrent growth of interest in accurate, fair, representative assessments that reflect what is being taught in reform curriculums is not surprising. Spokespeople for three major educational organizations briefly described the evaluation and assessment activities taking place under their auspices proceeding with NSF and/or ED financial support. Speaking for the **CCSSO** was **Project Director of the State Science and Mathematics Indicators Rolf K. Blank; Assistant Director for Policy Studies Linda P. Rosen** discussed **MSEB** evaluation activities (see page 23); ***SS&C* Director for Policy Studies Russell Aiuto** elaborated on the **NSTA** framework (see page 21).

The assessment component of ***SS&C*** is critical, Aiuto said, in measuring the project's impact. Traditional pen-and-paper, multiple-choice types of tests, however, are even more irrelevant to evaluating SS&C than they are to measuring most achievement.

Accordingly, the focus of [NSTA Executive Director] Aldridge's work on SS&C has turned to student assessment and, with the help of $400,000 of ED funds, he has designed a prototypical performance-based assessment, which will run on the commercially available Phillips Consumer Electronics Compact Disk Interactive player (CD-I). Development of this tool has been ongoing for over two years; much work lies ahead.

"There *will* be some kind of a national examination system in the United States in the very near future," the **MSEB's** Rosen asserted. Groups—from local school boards to the National Commission on Testing and Public Policy—and individuals—from a worried parent to President Bush—interested in educational assessment and accountability are vying for power over the process.

"From individual classrooms, to state departments of education, to national organizations such as the NCTM or the MSEB, mathematics educators are demanding their say," Rosen said. Out of the MSEB's assessment activities have come three guiding principles: The primary purpose of assessment is to improve learning and teaching; its results should be used primarily to develop all people's talents; and its content should be derived from each discipline's consensus.

Like those at the MSEB working on assessment projects, mathematics educators across the nation are insisting that assessments change from "traditional, standardized, multiple-choice, norm-referenced tests that yield single numerical descriptors" to "multiple measures of performances on standards-referenced assessments that include open-ended questions and problems, essays, oral presentations, demonstrations (including computer demonstrations), projects, investigations and experiments, and models and simulations," Rosen said. She concluded that assessments must stop merely "ranking, labeling, sorting, classifying, and qualifying individuals." Instead, assessments must affirm and serve their primary purpose—"to improve learning by giving teachers, students, and parents information about the mathematics students know as well as the mathematics they have yet to learn."

To order the *Indicators* ($12) and other project reports, contact the CCSSO, 1 Massachusetts Ave., N.W., Suite 700, Washington, DC 20001-1431. Telephone: (202) 408-5505.

CCSSO's Project

The fruit of five years of data collection is now available, reported the **CCSSO's** Blank. In 1991, the CCSSO published the first edition of *State Science and Mathematics Indicators: 1990*, which provides for the first time state-by-state data on the condition of science and mathematics education in the schools. This report contains comparable state data on students and teachers from information systems of state departments of education and from the NCES' *Schools and Staffing Survey* (1988), which includes sample data on teachers by state and nationally. Initiated in 1986, the *Indicators* project plans to update its findings in 1992.

The CCSSO is also active in working with states to improve methods of student assessment. This year, the Project is working with the NSF and the NCES on collecting better data on professional development and science and mathematics curricular content.

Communities at Work:

Curriculum Frameworks in the States

Speaking on the role of the states in creating worldclass curriculums in mathematics and science were **Judy Carson, associate director of Connecticut's *State Systemic Initiative*, Thomas P. Sachse, California state science supervisor** and contributor of the paper *The State as the Centerpiece* to the Clearinghouse meeting (see page 31), and **Charles D. Watson, Arkansas state mathematics supervisor.** All three are Eisenhower coordinators for elementary and secondary education working in their respective state departments of education. Carson, Sachse, and Watson agreed that traditional science and mathematics curriculums, often defined by state legislators' demands for accountability, tended to stress memorization rather than higher level thinking. In contrast, today's innovators in science and mathematics education call for global approaches that develop thinking, problem solving, and process skills. Students need to work in groups; they need to learn through technology; they need a model that stresses *concepts* rather than low-level, but countable, facts.

Arkansas

Watson noted that his state's reform efforts in mathematics rest squarely on the NCTM's *Standards*. Committees have worked to develop a state framework for mathematics that provides direction for teachers at each grade level. Embracing the *Standards'* central pedagogical point that mathematics is much more than content, Watson emphasized the importance of goals without which curricular reform is irrelevant: He said that students must learn to value mathematics, become confident in their own ability, learn to reason mathematically, to communicate mathematically and to become mathematical problem solvers.

California

Sachse explained that California reformers are working from the base of a "constitutional mandate," which directs the state board of education to create frameworks for mathematics and science as well as all other subjects. Once in place, these guidelines are meant to link disciplines that now often are studied in isolation. Like Connecticut, California's goals are framed in the "centrist" spirit of *Project 2061*, which connects science not only to technology but also to as many other fields as possible. Science in California, Sachse, said, aims to be "nondogmatic," to apply to society, to open pathways to understanding. Affirming the approach of writers like Lewis Thomas and Stephen Jay Gould, the *Network* document defines 45 major concepts in science that are elaborated K-12 with increasing complexity. In this, it also follows the precepts of NSTA's *SS&C*.

California has also adopted a mathematics framework, Sachse said.

Like Carson and Watson, Sachse stressed the importance of "constructivism," of students' involvement in their own learning. "Active learning," Sachse said, leads to "student ownership" of education.

*For a copy of the *California Science Implementation Network*, contact the Bureau of Publications Sales Unit, California Department of Education, PO box 271, Sacramento, CA 95802-0271. Telephone: (916) 445-1260. Cost: $6.50.

Connecticut

Carson said her state's systemic initiative rests on five principles/institutions:

- The Connecticut Academy for Mathematics, Science, and Technology Education provides leadership and direction, does research, lobbies, and disseminates information and model practices.
- The plan for curricular reform has several clear focal points. Its primary priority is assistance for disadvantaged school districts. Five chosen districts receive assistance for a period of three years, and five new districts join each year. Working first with grades four through eight, educators are designing an action plan that stresses hands-on learning. They will then pilot programs that include staff development, while continuing to plan K-12. Finally, with school board support, this reform will be institutionalized.
- The reform includes extensive preservice teacher preparation and inservice professional development.
- The state is creating an environment conducive to change, supporting museums, involving business and industry, and bringing scientists into the schools.
- The public awareness campaign is working to change attitudes and to increase state commitment to mathematics and science education.

Never Look Back

Education Consultant Cathy L. Seeley of Texas believes that in teaching and learning mathematics, repeating what has seemed to work in the past offers little help for the present and none for the future. In a world where the amount of information is exponential or, at least, "no longer linear,"* while the past may be prologue, change, not tradition, must be the rule.

Seeley, who works in professional development with many mathematics teachers in Texas's 1,100 school districts, noted a number of approaches *not* to take to change the way teachers teach and children learn math. A formula for failure: Track students; emphasize pencil and paper computations, drills, and practices; repeat every year what was done before; have students work alone (evaluating cooperative work is difficult); use math as a way of filtering poor students out of the pool.

She also criticized policies that, on the one hand, keep students at one level to avoid "frustrating" them, or, on the other, push all through, regardless of learning. "Simply changing requirements and getting rid of 'low-level' courses won't help either," Seeley noted. Unless teachers change the way they teach, such approaches are merely cosmetic and can result in watered-down curriculums.

In one school, said Seeley, where "everyone had to take algebra," the result was *five* levels of algebra.

The Historical Approach

According to the University of Wisconsin's Tom Romberg, typical American mathematics students do

- 8 years of 15th-century arithmetic
- 2 years of 17th-century algebra
- 1 year of 3rd-century B.C. geometry

Increasing Access—Pragmatism Joins Idealism

Preschool and kindergarten populations generally reflect the racial and ethnic proportions measured by the census, Seeley noted, with understandable local fluctuations. But the roughly two-thirds of the originally culturally mixed four and five year olds who will finally graduate from high school will be filtered—They will be mostly white males.

Joining the moral and ethical protests of educators to this outcome are the complaints of business and industry leaders, who are no longer looking for workers with strong backs, quick hands, and basic arithmetic, Seeley said. Tomorrow's work force will come in large part from populations underrepresented today in science and technology—women and minorities. The best educated graduates will be the most employable. To broaden access and to modernize the way most students learn mathematics, a number of changes must take place.

"We have to stop sifting kids out," Seeley said. "by changing the way we are teaching. We have to start getting kids ready for success in algebra."

Calculators and computers, she pointed out, are essential to effective math and science today in a way they weren't thought to be in the past.

Improving Training

Seeley offered tips on how to make inservice teacher training most effective.

She suggested that trainers invest in the long haul (so programs won't have to be redone), noting that a number of the National Science Foundation Statewide Systemic Initiatives combine programs and approaches to achieve maximum leverage.

Trainers should also look to tomorrow's needs, Seeley emphasized, using, for example, the National Council of Teachers of Mathematics' *Standards* and the developing science standards (see page 23-24).

"Don't forget the content," she cautioned, which is changing and growing, "but teachers don't need to be research scientists or mathematicians. Proportional thinking in math is not taught in graduate school, for example, but is essential in school."

Training should be packaged to appeal to the audience. "Elementary school teachers are often scared of graduate school," she said. "but they like neat little 12-hour math modules."

Finally, Seeley stressed the need to reward professionalism. Participants don't need "big bucks," though *they should be paid*. A big certificate with gold seals is a good idea.

"Teachers are the key," she summarized, and "Staff development is a life-long affair."

*John A. Dossey, past president of National Council of Teachers of Mathematics, personal communication.

Math -ematicians -ematics Educators -ematics Teachers: What Makes "Inservice" Programs Successful

Rutgers University mathematician Joseph G. Rosenstein took time off from directing the New Jersey Mathematics Coalition, attending numerous conferences, directing three projects (two funded by Eisenhower and one by the National Science Foundation), and being with his family to give conferees some pointers how to help teachers do their jobs better and more easily. Rosenstein, who dislikes the terms "inservice" and "enhance," prefers instead to emphasize collaboration. "We need to work together to improve mathematics education.

"Finger-pointing is unproductive," Rosenstein said, although he admitted it goes on. He describes himself as a "mathematical social worker" trying to help teachers change.

Working through the Rutgers University Center for Math, Science, and Computer Education and the Center for Discrete Mathematics and Theoretical Computer Science, Rosenstein directs programs for new teachers, for those teaching precalculus, and for those interested in discrete mathematics. All the programs follow five general principles.

Principles for Success

No matter what their ultimate purpose (for example, to upgrade content knowledge or to enhance self-image), Rosenstein's sessions always ***treat teachers as professionals,*** with university faculty modelling the desired effect by interacting with teachers as colleagues. Participants' views and needs must be taken seriously, Rosenstein said, recommending frequent use of—and immediate response—to evaluation forms. And provide the amenities, he warned—coffee and the like.

Second, he continued, ***"Always consider the limitations of the school environment":*** Provide the opportunities not usually available in busy school environments for sharing, for thinking, and for reflecting. Successful programs have demonstrated value; they connect to classrooms; they are flexible; and they pay attention to human details.

Third, Rosenstein recommends that programs ***motivate teachers to become leaders.*** Teachers are an "underutilized resource," he said. They need to get out of their school buildings and share their expertise. "Help them feel that they are part of something important," he said: "Whatever you think about the idea of trying to be first in the world in math and science by 2000, the goal of being number 1 has a certain ring to it."

Fourth, Rosenstein noted, Of course "You must ***provide quality programs***" with valuable, relevant materials and first-rate staff. The manner should be "professional but informal and collegial" and the effort should be collaborative and flexible. Leaders should not hesitate to solicit and make changes if a conference doesn't seem productive.

Finally, he finds it important to ***provide context and follow-up,*** encouraging networks, continuing to coordinate with schools, and finding other opportunities for involvement.

Cathy L. Seeley, see article on facing page

State Breakout Sessions

Coalescing at times into separate components—elementary and secondary and higher education—to focus on particular issues, state Eisenhower leaders met in ten separate formal and informal sessions to share ideas on administering the nation's largest mathematics and science program. Conferees investigated Eisenhower's links with systemic change, the Program's attempts to build a cadre of teacher leaders, and the characteristics of successful programs. Some comments follow.

We have to have the numbers, but we really need is to know is, What are the needs of the teachers? We see *you* as the leaders.

—Alicia Coro

♦

The models must change: We must focus both on content and pedagogy, both on quality and on equity.

—Lee E. Wickline

Goals: We need to

- work on better collaboration among State Education Agencies (SEAs), State Agencies for Higher Education (SAHEs), Local Education Agencies (LEAs), and the national programs
- link with professional math and science organizations both regionally and nationally, attend their meetings, and network among ourselves electronically
- engage with many federal agencies—as well as ED and the National Science Foundation
- tie Eisenhower to the systemic change initiative

Leadership

Observation: Eisenhower is a network for leaders in science and math reform.

Dilemma: We have so many teachers who need to be recycled, who haven't been retrained for years.

Suggestion: How about using 5 percent of funds to develop a pyramid of mentors?

Observation: We need to get away from the idea that Eisenhower higher education programs are not just to improve K-12 teachers. Ike should also retread college faculty.

Caution: Remember other federal agencies do most of the retraining of university staff.

Promise: When we see a program that's working, we don't touch it: If it's not broken, we don't fix it.

*The Carnegie Report**

Observations: In the late 1950s, when Sputnik orbited, money, including that from the National Defense Education Act, became available for mathematics and science equipment and materials. The first science and math supervisors appeared in state departments of education. There were massive federal developments in biology, chemistry, physics. But as the crisis waned, so did federal support. Are we in the same situation now?

The *Carnegie Report* talks about systemic reform—beyond the educational community. Lamar Alexander agrees: Collaborative efforts are essential. The work of the 1950s and 1960s didn't have the impact many of us wished it did because it was not broad based.

The *Report* speaks of "diffusion." As educators, we probably have done worst at dissemination of working programs and approaches. But what we do has little effect unless the behavior of teachers in the classroom changes.

We are now involved in the inservice training of teachers; we need also to become involved in preservice.

The amount of money spent in local districts on individual teachers is minuscule—$3/pupil; $75/teacher; still the *SRI Report* (1991) found that Eisenhower provided most or all of the funding for training of teachers in math and science.

*The Carnegie Commission on Science, Technology, and Government, *In the National Interest: The Federal Government in the Reform of K-12 Math and Science Education* (New York: Author).

National Conferences

During the seven separate occasions—formal and informal—that participants in Eisenhower national programs gathered to share wisdom, pitfalls, and advice, conferees made many observations, asked many questions, offered many suggestions. A very few follow:

Question: What does it mean to "validate" a program being submitted to ED?

Response: Department reviewers look for evidence that an idea has been developed, that specific effects are projected, that data has been—and will be—collected, and that dissemination and training of others is planned.

Observation: *America 2000* is held up in many places by resistance to choice. We must not let this happen.

Welcoming Mathematics and Science Supervisors

As formal invitees to the Eisenhower National Conference for the first time, participating supervisors broke into four "role-alike" groups* to consider a number of questions, including

1. What role are you having in Ike?
2. How can Eisenhower improve partnerships between state, local, and national components?
3. How are you involved with your Eisenhower coordinator?
4. What could be done at the federal or local level to facilitate improved state involvement?

Observation: In some states Ike coordinators and math and science supervisors don't work together. Let's work to change this. The new Eisenhower form will require interviews of all math and science coordinators.

Observation: The most important contact for an Eisenhower coordinator is the math and science supervisor, but not every state has one.

Observation: Every state's math supervisor was loaned hard- and software to communicate electronically with other math education leaders.

Response: You can communicate with ED through its electronic networks. Many schools and states are setting up their own networks. In addition, Eisenhower administrative money maintains a 1-800 number to help schools keep in touch.

Plan: We must match the people with need with those who have ability to fulfill it.

Suggestion: Participants should present at their state Science Teachers Association meetings to develop a network.

Summary: I don't care who developed the agenda—from the top down or the bottom up—as long as it helps Eisenhower help teachers better.

Eisenhower coordinators at this meeting were Lee E. Wickline, Claire Gifford, and Rick Davis.

*These groups broke roughly into (a) state mathematics consultants, (b) state science supervisors, (c) regional and intermediate-level mathematics, science, and Eisenhower coordinators, and (d) "everybody else."

The "last frontier" is a myth. There will be more new frontiers in the coming year than in all of human history. The real frontiers are not of land, water, wind, and space—but of the infinite possibilities of the spirit and mind.

—Allen A. Schmieder
Profound Simplitude Series

The Eisenhower National Clearinghouse

(During concurrent sessions, conferees offered their input to the authors of commissioned papers exploring aspects of the Clearinghouse. Abstracts follow.)

National Clearinghouse: Agent of Transformation through Professional Development

Citing the underutilization of existing science and math dissemination systems by K-12 educators, the authors argue for the creation of a new system incorporating restructured roles of teachers, a supportive organizational infrastructure, interactive technologies, a constructivist approach to learning, and the active involvement of the two major teacher organizations.

Bruce Goldberg, The American Federation of Teachers; **Gary D. Watts,** The National Education Association; and **Ronnie B. Lowenstein,** The International Society for Technology in Education

Scope and Standards for a National Clearinghouse for Science, Mathematics, and Technology Education Materials

The author discusses the role of a national clearinghouse in improving the quality of science and mathematics teaching, arguing that its functions need to go beyond that of a repository and extend to active dissemination. She proposes a quality-control strategy so that, while all materials and programs submitted are deposited in the clearinghouse, those slated for active dissemination are critically reviewed. She also reviews possible services and their evaluation.

Susan Loucks-Horsley, The NETWORK, Inc.

The International Focal Point of the Eisenhower Clearinghouse

The authors emphasize that a focused effort to collect information on science and mathematics education internationally would strengthen the Eisenhower National Clearinghouse since knowledge of what is working well in other countries is extremely important to improving related U.S. activities. They recommend that a separate, coordinated structure be established that uses advanced technologies for information collection and dissemination.

J. David Lockard, International Clearinghouse for the Advancement of Science Teaching, University of Maryland;
Robert W. Howe, formerly of ERIC and the Environmental Quality Instructional Resources Center, Professor Emeritus, The Ohio State University;
Diane Patrick, University of Maryland; and
Charles R. Warren, Ohio State Department of Education

Building on Existing Systems

The paper notes many existing systems and discusses implications of systems for the Clearinghouse. The Clearinghouse should be a central node connecting users with existing systems, and networking existing science- and mathematics-rich systems with general education systems. To prevent unwarranted overlap of missions and services, Clearinghouse designers should comprehensively survey existing systems.

Senta A. Raizen and **Edward D. Britton,** The National Center for Improving Science Education

The State as the Centerpiece

The author describes the relationship of state departments of education to the functions of the national clearinghouse and regional consortia. He compares the states in terms of perspective and roles with regard to accessing math, science, and technology education materials and programs.

Thomas P. Sachse, California Department of Education

Technology and the National Clearinghouse for Mathematics and Science Education

The author considers the role of technology in the Eisenhower Clearinghouse. He argues for extensive employment of telecommunications and CD-ROMs using a unified approach that integrates text, data, graphics, graphs, and other formats. Promulgating this new medium would be an important step for mathematics and science education.

Robert F. Tinker, Technical Education Research Centers, Inc.

The Consortia

In response to the urgent call to meet the fourth national goal, Capitol Hill coupled the Eisenhower Clearinghouse legislation with a call for the creation of regional consortia to facilitate the systemic reform now occurring nationwide. Eisenhower conferees broke into seven groups organized by region to discuss how the consortia—funded at $12 million—could best increase the Clearinghouse's impact in supporting state efforts to improve mathematics and science education.

Helping Reform

A number of groups cited dissemination as paramount—both sharing successes originating in a given district or region and also bringing in experts to inform and be informed. Individual regional groups

- encouraged a strong emphasis on programs; suggested that regional consortia be linked with the Clearinghouse and individual teachers, schools, and districts, both electronically and by traditional means
- noted that the consortia could connect preservice teachers with those in the field and thereby improve teacher training
- commented on the desirability of using existing communications technology, such as PsiNet™, to connect the consortia with the Clearinghouse and with the states
- stressed the need to help "key people" interact and to keep members current with new research
- pointed out the importance of consulting all constituents in the planning stages
- emphasized the importance of working with the National Science Foundation's Statewide Systemic Initiative and the Education Commission of the States
- believed the consortia should work on preservice criteria, qualifications for certification, and inservice strategies

Four National Initiatives

The 1991-1992 Eisenhower National Program is supporting four special initiatives important to the continuing reform of teaching and learning in science and mathematics nationwide.

- *For families and communities*, it stresses the kind of **informal science education** that takes place in museums, science centers, tours through businesses and technological complexes, and the like.
- *For teachers*, it is investigating, first through the November 21-22 post-convention workshop led by Oregon's Ralph Nelson,* then through the Triangle Coalition's National Eisenhower Grant, the ways in which to achieve the best in **short-term professional development.**
- *For students*, it affirms the efficacy of using
  - **hand-held calculators** in the classroom and
  - approaching science **hands-on**

*For further information on the work of this group, contact Ralph Nelson, Columbia Education Center, 11325 S.E. Lexington, Portland, OR 97266-5927. Telephone: (503) 760-2346.

Technical Assistance—What Kind?

Do

evaluate and assess students and programs
localize curriculums (no snow in Puerto Rico; no mountains in Iowa)
encourage teacher leadership
network teachers with content experts
foster good public relations
teach grant writing
involve business and industry
disseminate effective products
help the underserved/underrepresented
reduce isolation of teachers
hold useful meetings, perhaps by satellite
train teachers to use new technologies, including distance learning
serve as local versions of the Federal Coordinating Council for Science, Engineering, and Technology
produce and make available instructional materials, including software and videotapes

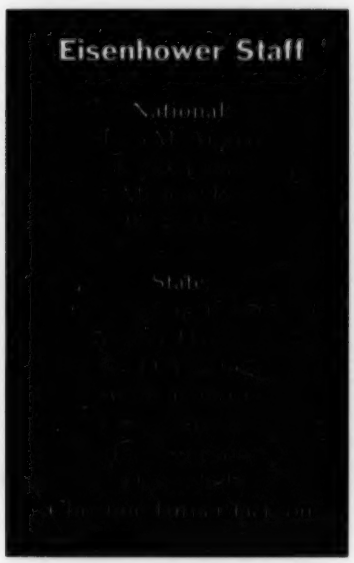
Do not

Create another bureaucracy

Who Should Belong?

State legislators and governors' designates, representatives of business and the community, designates from public and professional agencies, teachers, science and mathematics education leaders at all educational and administrative levels (including state science and mathematics supervisors and staff from regional labs), representatives of educational organizations, Eisenhower coordinators, members of boards of education, designates from ED and other federal agencies, parents

The View from the Department



Diane Ravitch, Assistant Secretary and Counselor to the Secretary:
What our nation needs in order to increase math and science achievement are "worldclass" standards in math and science, K-12 state curriculum frameworks by which to achieve them, and assessments that enrich instruction and encourage children to learn what they need to know for the 21st century.

John T. MacDonald, Assistant Secretary for Elementary and Secondary Education:
It is a thrill to talk with teachers and supervisors and to hear them say how grateful they are for the Eisenhower funds which help them become better teachers of mathematics and science.

Paul Gagnon, Director, Fund for the Improvement and Reform of Schools and Teaching:
Better math and science will not just help us to compete on earth; they will help us understand both the great hopes and the great perils in the choices we must make as citizens.

Alicia Coro, Director, School Improvement Programs:
Reforms in mathematics and science education require vastly new and different skills for teachers. Eisenhower funding is a key factor in facilitating the ongoing training of teachers to meet the challenge.

Lee E. Wickline, Director, School Effectiveness Division:
Eisenhower funds help implement strong agendas: school-wide and district-wide curriculum reform, state frameworks, and national standards for mathematics and science.

Walter Steidle, Branch Chief, Mathematics and Science Education Program Branch:
The Dwight D. Eisenhower Program provides funds for training all teachers of mathematics and science, K-12 in all schools, according to specific needs levels.

Doris Crudup, Senior Program Officer, Mathematics and Science Education Program Branch:
Special efforts must be made to assure that the underrepresented, minorities, and women choose mathematics and science studies that prepare them to enter scientific careers.

Allen A. Schmeider, Director, Eisenhower National Programs for Mathematics and Science Education:
Three Laws of Education*

1. Minds without motion tend to remain without motion and in a straight line.
2. The acceleration of education is a function of the force of the faculty (teachers).
3. For every study, there is an equal and opposite study.

—*Profound Simplitude Series*

*Gratitude and apologies to Sir Isaac Newton's Three Laws of Motion.

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UNITED STATES DEPARTMENT OF EDUCATION

WASHINGTON, D.C. 20202-_____

Dear Eisenhower Conferees:

We welcome this opportunity to let you know how essential we find the work you are doing to change and strengthen the education of American youth in mathematics and science. As you are of course aware, having our students first in the world in these subjects by the year 2000 is the fourth national education goal adopted by the President and the Nation's governors. Your contribution to that aim has been significant. Eisenhower funds have helped one of every three teachers upgrade their skills annually in these vital and rapidly expanding areas of knowledge.

You are on the cutting edge of mathematics and science education and thus are also uniquely able to understand the necessity of a revolution, not just a reform, to achieve the goals of America 2000. Only with your determined effort will we have, by the next century

- Better and more accountable schools;
- Thousands of new-generation schools;
- Students whose learning continues beyond the classroom and throughout their lives;
- Communities where such teaching and learning can take place.

The Eisenhower program works on both the local and the national levels and focuses on classroom instruction changing as fast as American education must. This makes the program invaluable to the America 2000 strategy. Eisenhower affects, at the local level where America 2000 communities exist, about a third of the Nation's teachers each year and their students. Finally, staying up-to-date in the radically changing fields of science and mathematics is a responsibility for us all as citizens, one that may start in school but must continue as long as we live.

Reaching beyond educators and pupils, Eisenhower projects, like the America 2000 strategy, involve many members of the community: parents, business representatives, scientists, museum staff, and others. With your continuing efforts, the President's goal of making U.S. students first in the world in science and mathematics achievement by the year 2000 can be reached.

Thank you for your devotion to the task, and keep up the good work.

John T. MacDonald
Assistant Secretary for
Elementary and Secondary Education

Diane S. Ravitch
Assistant Secretary for
Educational Research and Improvement

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